CLAIMS

      1.   A method of forming a semiconductor layer structure, said method comprising:

      forming a modulation doped layer atop at least a portion of another layer by forming at least one sub-layer of doped nitride semiconductor and at least one sub-layer of undoped nitride semiconductor atop the at least portion of said another layer whereby said modulation doped layer has a doping concentration of at most 2E16 cm^{-3}.

      2.   A method as claimed in claim 1 wherein said forming step includes forming alternating sub-layers of doped nitride semiconductor and undoped nitride semiconductor atop the at least portion of said another layer.

      3.   A method as claimed in claim 1 wherein said forming step is carried out by a process selected from the group consisting of reactive sputtering, metal organic chemical vapor deposition (MOCVD), molecular beam epitaxy (MBE) and atomic layer epitaxy.

      4.   A method as claimed in claim 1 wherein said forming step includes diffusing dopants from said sub-layer of doped nitride semiconductor into said sub-layer of undoped nitride semiconductor to form said doped layer, said doped layer having a doping concentration that is substantially uniform.

      5.   A method as claimed in claim 1 wherein said modulation doped layer includes a gallium nitride-based semiconductor.

      6.   A method as claimed in claim 1 wherein said modulation doped layer includes GaN.

      7.   A method as claimed in claim 1 wherein said modulation doped layer is n-type.

      8.   A method as claimed in claim 1 wherein said modulation doped layer has a doping concentration of at least 4E15 cm^{-3}.

      9.   A method as claimed in claim 1 wherein said modulation doped layer has a thickness of at least 0.2 μm.

10. A method as claimed in claim 1 wherein said modulation doped layer has a thickness of at most 10 μm.

11. A method as claimed in claim 1 wherein said doped sub-layer of said modulation doped layer has a thickness of at least 0.005 μm.

12. A method as claimed in claim 1 wherein said doped sub-layer of said modulation doped layer has a thickness of at most 0.1 μm.

13. A method as claimed in claim 1 wherein said undoped sub-layer of said modulation doped layer has a thickness of at least 0.005 μm.

14. A method as claimed in claim 1 wherein said undoped sub-layer of said modulation doped layer has a thickness of at most 0.1 μm.

15. A method of forming a Schottky junction including forming a modulation doped layer as claimed in claim 1 and forming a metal contact layer atop said modulation doped layer.

16. A method of forming a Schottky diode including forming a Schottky junction as claimed in claim 15 and forming an ohmic contact on another portion of said another layer.

17. A method of forming a Schottky diode, said method comprising:

forming a modulation doped layer atop at least a portion of another layer by forming at least one sub-layer of doped nitride semiconductor and at least one sub-layer of undoped nitride semiconductor atop the at least portion of said another layer;

forming a metallic contact layer atop at least part of said modulation doped layer to form a Schottky junction therewith; and

forming at least one further metallic contact layer on at least part of said another layer in substantially ohmic contact therewith;

whereby a ratio of an on-resistance of said Schottky diode to a breakdown voltage of said Schottky diode is at most 2×10^{-5} $\Omega \cdot cm^2/V$.

18. A method as claimed in claim 17 wherein said step of forming a modulation doped layer includes forming alternating sub-layers of doped nitride semiconductor and undoped nitride semiconductor atop the at least portion of said another layer.

19. A method as claimed in claim 17 wherein said step of forming a modulation doped layer is carried out by a process selected from the group consisting of reactive sputtering, metal organic chemical vapor deposition (MOCVD), molecular beam epitaxy (MBE) and atomic layer epitaxy.

20. A method as claimed in claim 17 wherein said modulation doped layer includes a gallium nitride-based semiconductor.

21. A method as claimed in claim 17 wherein said modulation doped layer includes GaN.

22. A method as claimed in claim 17 wherein said modulation doped layer is n-type.

23. A method as claimed in claim 17 wherein said modulation doped layer has a thickness of at least 0.2 μm.

24. A method as claimed in claim 17 wherein said modulation doped layer has a thickness of at most 10 μm.

25. A method as claimed in claim 17 wherein said doped sub-layer of said modulation doped layer has a thickness of at least 0.005 μm.

26. A method as claimed in claim 17 wherein said doped sub-layer of said modulation doped layer has a thickness of at most 0.1 μm.

27. A method as claimed in claim 17 wherein said undoped sub-layer of said modulation doped layer has a thickness of at least 0.005 μm.

28. A method as claimed in claim 17 wherein said undoped sub-layer of said modulation doped layer has a thickness of at most 0.1 μm.

29. A method as claimed in claim 17 wherein said first metal contact layer is selected from the group consisting of platinum (Pt), palladium (Pd), and nickel (Ni).

30. A method as claimed in claim 17 wherein said another layer comprises another doped layer of nitride semiconductor that is formed atop a substrate prior to forming said doped layer, said doped layer and said another doped layer being of the same conductivity type, said another doped layer being more highly doped than said doped layer.

31. A method as claimed in claim 30 wherein said another doped layer includes a gallium nitride-based semiconductor.

32. A method as claimed in claim 30 wherein said another doped layer includes GaN.

33. A method as claimed in claim 30 wherein said another doped layer is n-type.

34. A method as claimed in claim 30 wherein said another doped layer has a doping concentration of at least $4E18$ cm^{-3}.

35. A method as claimed in claim 30 wherein said substrate is selected from the group consisting of sapphire, silicon carbide, doped silicon and undoped silicon.

36. A method as claimed in claim 17 wherein said ohmic metal contact layer is selected from the group consisting of aluminum/titanium/platinum/gold (Al/Ti/Pt/Au) and titanium/aluminum/platinum/gold (Ti/Al/Pt/Au).

37. A semiconductor layer structure, comprising:

a modulation doped layer of nitride semiconductor disposed atop another layer, said modulation doped layer including at least one sub-layer of doped nitride semiconductor and at least one sub-layer of undoped nitride semiconductor disposed atop at least a portion of said another layer whereby said modulation doped layer has a doping concentration of at most $2E16$ cm^{-3}.

38. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer includes

alternating sub-layers of doped nitride semiconductor and undoped nitride semiconductor disposed atop at least a portion of said another layer.

39. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer includes a gallium nitride-based semiconductor.

40. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer includes GaN.

41. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer of nitride semiconductor is n-type.

42. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer of nitride semiconductor has a doping concentration of at least 4E15 cm^{-3}.

43. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer has a thickness of at least 0.2 μm.

44. A semiconductor layer structure as claimed in claim 37 wherein said modulation doped layer has a thickness of at most 10 μm.

45. A semiconductor layer structure as claimed in claim 37 wherein said doped sub-layer of said modulation doped layer has a thickness of at least 0.005 μm.

46. A semiconductor layer structure as claimed in claim 37 wherein said doped sub-layer of said modulation doped layer has a thickness of at most 0.1 μm.

47. A semiconductor layer structure as claimed in claim 37 wherein said undoped sub-layer of said modulation doped layer has a thickness of at least 0.005 μm.

48. A semiconductor layer structure as claimed in claim 37 wherein said undoped sub-layer of said modulation doped layer has a thickness of at most 0.1 μm.

49. A Schottky junction including a semiconductor layer structure as claimed in claim 37 and a first metal contact layer disposed atop said modulation doped layer such that a Schottky contact is formed.

50. A Schottky diode including a Schottky junction as claimed in claim 49 and a second metal contact layer disposed on at least part of said another layer such that an ohmic contact is formed.

51. A Schottky diode, comprising:

a modulation doped layer of nitride semiconductor disposed atop another layer, said modulation doped layer including at least one sub-layer of doped nitride semiconductor and at least one sub-layer of undoped nitride semiconductor;

a metallic contact layer disposed atop at least part of said modulation doped layer to form a Schottky junction therewith; and

at least one further metallic contact layer disposed on at least part of said another layer in substantially ohmic contact therewith;

whereby a ratio of an on-resistance of said Schottky diode to a breakdown voltage of said Schottky diode is at most 2×10^{-5} $\Omega \cdot cm^2/V$.

52. A Schottky diode as claimed in claim 51 wherein said modulation doped layer includes alternating sub-layers of doped nitride semiconductor and undoped nitride semiconductor disposed atop at least a portion of said another layer.

53. A Schottky diode as claimed in claim 51 wherein said modulation doped layer includes a gallium nitride-based semiconductor.

54. A Schottky diode as claimed in claim 51 wherein said modulation doped layer includes GaN.

55. A Schottky diode as claimed in claim 51 wherein said modulation doped layer of nitride semiconductor is n-type.

56. A Schottky diode as claimed in claim 51 wherein said modulation doped layer of nitride semiconductor has a doping concentration of at least 4E15 cm^{-3}.

57. A Schottky diode as claimed in claim 51 wherein said modulation doped layer has a thickness of at least 0.2 µm.

58. A Schottky diode as claimed in claim 51 wherein said modulation doped layer has a thickness of at most 10 µm.

59. A Schottky diode as claimed in claim 51 wherein said doped sub-layer of said modulation doped layer has a thickness of at least 0.005 µm.

60.. A Schottky diode as claimed in claim 51 wherein said doped sub-layer of said modulation doped layer has a thickness of at most 0.1 µm.

61. A Schottky diode as claimed in claim 51 wherein said undoped sub-layer of said modulation doped layer has a thickness of at least 0.005 µm.

62. A Schottky diode as claimed in claim 51 wherein said undoped sub-layer of said modulation doped layer has a thickness of at most 0.1 µm.

63. A Schottky diode as claimed in claim 51 wherein said first metal contact layer is selected from the group consisting of platinum (Pt), palladium (Pd), and nickel (Ni).

64. A Schottky diode as claimed in claim 51 wherein said another layer includes another doped layer of nitride semiconductor formed atop a substrate, said doped layer and said another doped layer are of the same conductivity type, and said another doped layer is more highly doped than said doped layer.

65. A Schottky diode as claimed in claim 64 wherein said another doped layer includes a gallium nitride-based semiconductor.

66. A Schottky diode as claimed in claim 64 wherein said another doped layer includes GaN.

67. A Schottky diode as claimed in claim 64 wherein said another doped layer is n-type.

68. A Schottky diode as claimed in claim 64 wherein said another doped layer has a doping concentration of at least 4E18 cm^{-3}.

69. A as Schottky diode claimed in claim 64 wherein said substrate is selected from the group consisting of sapphire, silicon carbide, doped silicon and undoped silicon.

70. A Schottky diode as claimed in claim 51 wherein said ohmic metal contact layer is selected from the group consisting of aluminum/titanium/platinum/gold (Al/Ti/Pt/Au) and titanium/aluminum/platinum/gold (Ti/Al/Pt/Au).

71. A method of forming a Schottky diode, said method comprising:

forming a lower layer of n-type doped nitride semiconductor atop a substrate;

forming an upper layer atop at least a portion of said lower layer of nitride semiconductor by forming alternating sub-layers of n-type doped nitride semiconductor and undoped nitride semiconductor, said sub-layers being formed by a process selected from the group consisting of reactive sputtering, metal organic chemical vapor deposition (MOCVD), molecular beam epitaxy (MBE) and atomic layer epitaxy, said lower layer of nitride semiconductor being more highly doped than said upper layer of nitride semiconductor;

forming a first metal contact layer atop said upper layer of nitride semiconductor such that a Schottky contact is formed; and

forming a second metal contact layer atop said lower layer of nitride semiconductor such that an ohmic contact is formed;

whereby a ratio of an on-resistance of said Schottky diode to a breakdown voltage of said Schottky diode is at most 2×10^{-5} $\Omega \cdot cm^2/V$.

72. A method as claimed in claim 71 wherein at least one of said upper layer of nitride semiconductor and said lower layer of nitride semiconductor includes a gallium nitride-based semiconductor.

73. A method as claimed in claim 71 wherein at least one of said upper layer of nitride semiconductor and said lower layer of nitride semiconductor includes GaN.

74. A Schottky diode, comprising:

a lower layer of n-type doped nitride semiconductor disposed atop a substrate;

an upper layer of nitride semiconductor disposed atop at least a portion of said lower layer of nitride semiconductor, said upper layer of nitride semiconductor including alternating sub-layers of n-type doped nitride semiconductor and undoped nitride semiconductor, said lower layer of nitride semiconductor being more highly doped than said upper layer of nitride semiconductor;

a first metal contact layer disposed atop said upper layer of nitride semiconductor such that a Schottky contact is formed; and

a second metal contact layer disposed atop said lower layer of nitride semiconductor such that an ohmic contact is formed;

whereby a ratio of an on-resistance of said Schottky diode to a breakdown voltage of said Schottky diode is at most 2×10^{-5} $\Omega \cdot cm^2/V$.

75. A Schottky diode as claimed in claim 74 wherein at least one of said upper layer of nitride semiconductor and said lower layer of nitride semiconductor includes a gallium nitride-based semiconductor.

76. A Schottky diode as claimed in claim 74 wherein at least one of said upper layer of nitride semiconductor and said lower layer of nitride semiconductor includes GaN.